

Active learning of a specialization from an IGMM

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Introduction

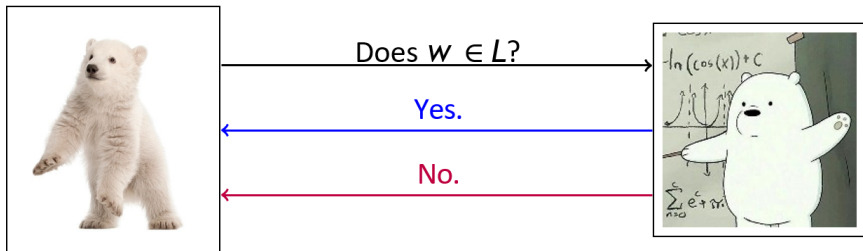
Motivations

Learn and understand the behavior of black box systems.

Active Learning

Minimally adequate teachers[1][2]

The student can submit **membership** queries.

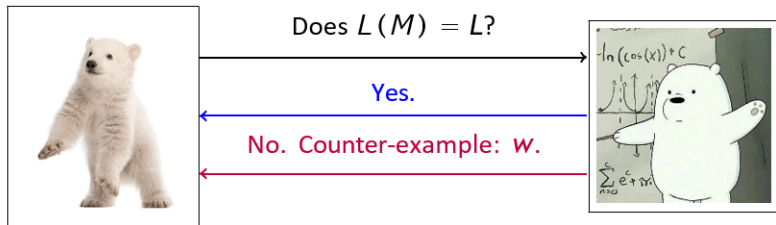


¹Dana Angluin. Learning regular sets from queries and counterexamples.

²Falk Howar et al. The teachers' crowd: The impact of distributed oracles on active automata learning.

Equivalence Queries

The student can also submit **equivalence** queries.

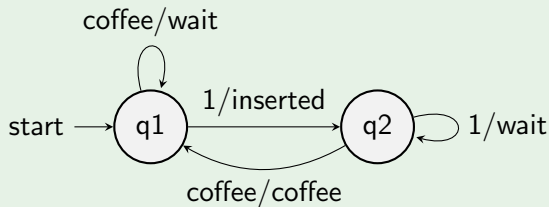


Warning

These queries are complex to answer (if it is even possible) and should be used conservatively.

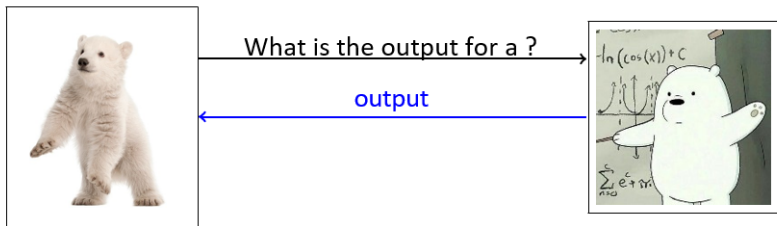
Mealy Machines

Example: Coffee machine modelization



Membership Queries^[1][3]

The student can submit **output** queries.



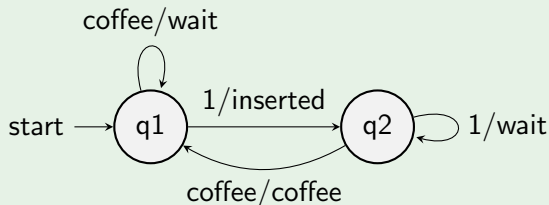
These queries can be answered by merely running the black box.

¹Dana Angluin. Learning regular sets from queries and counterexamples.

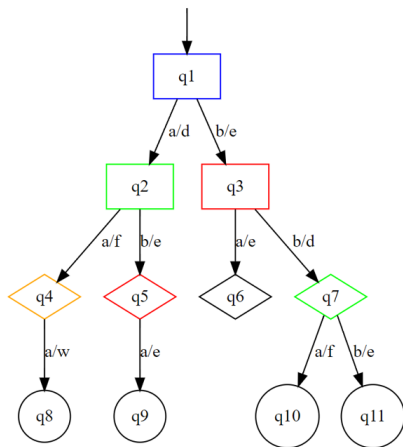
³Frits W. Vaandrager et al. A New Approach for Active Automata Learning Based on Apartness.

L# Apartness

Example: Coffee machine modelization



L# Observation Tree



Basis State



Frontier State



Other State

Build hypothesis

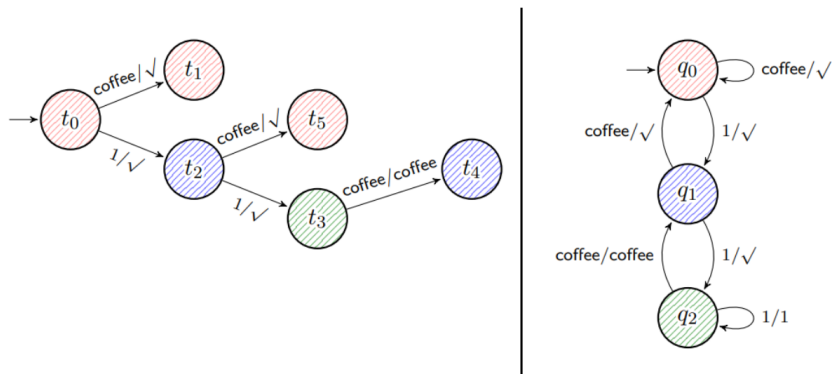
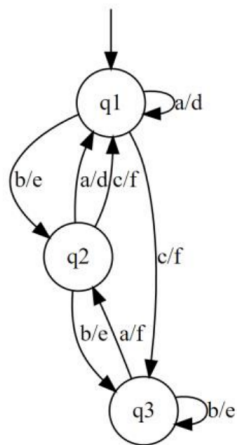
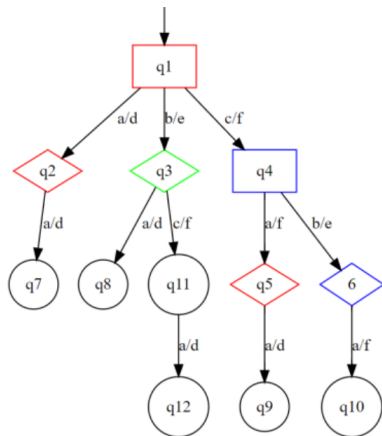


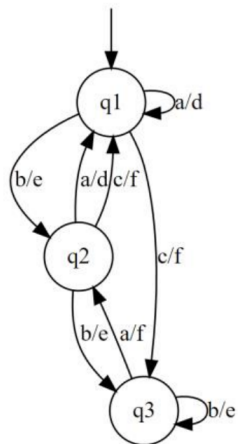
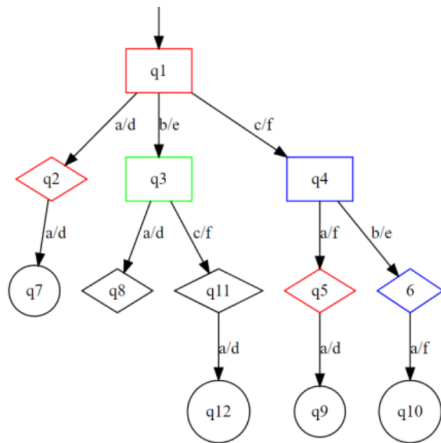
Figure: Coffee machine[4]

³Daniel Neider et al. Benchmarks for automata learning and conformance testing

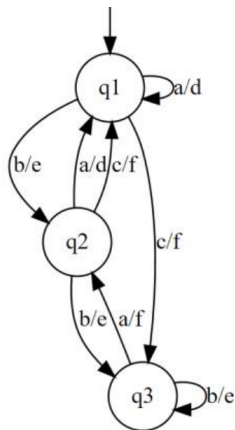
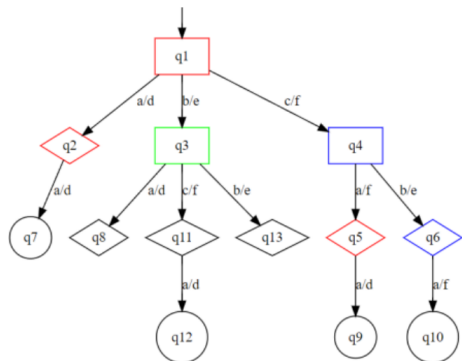
Execution



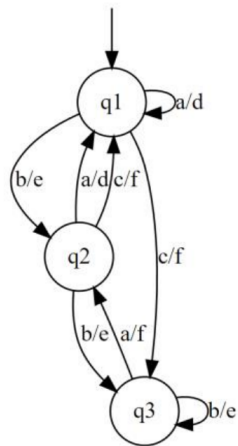
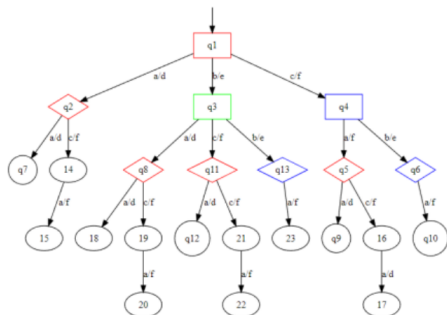
R1



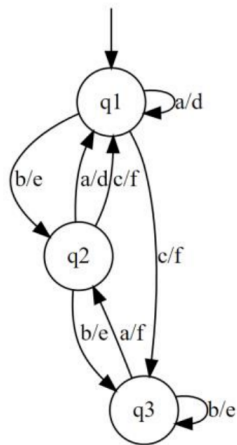
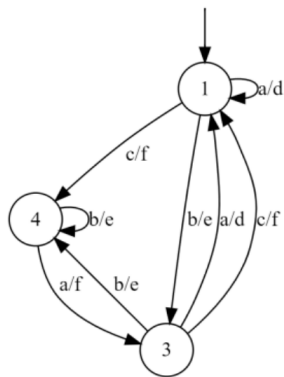
R2



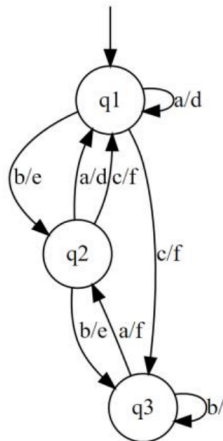
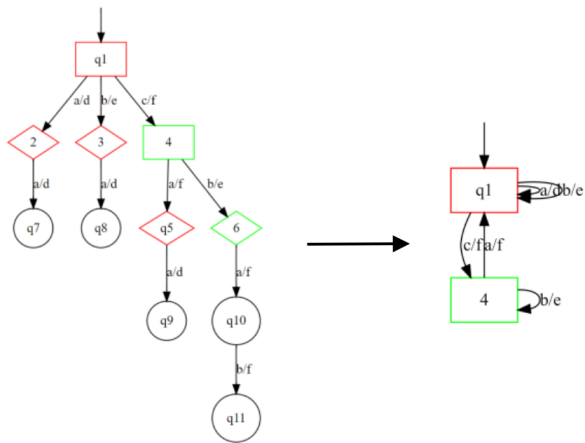
R3



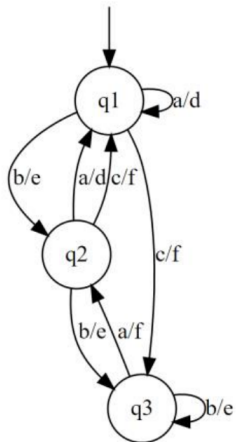
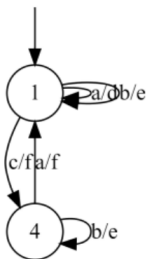
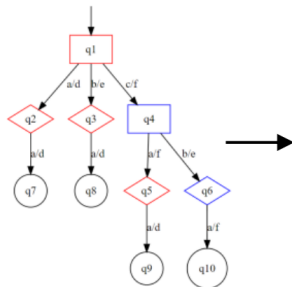
R4



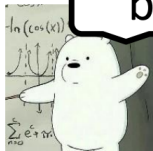
Check consistency



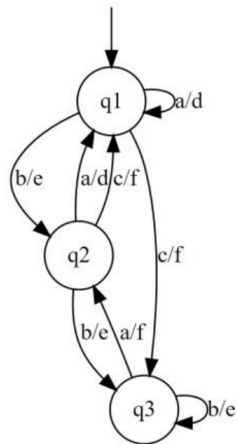
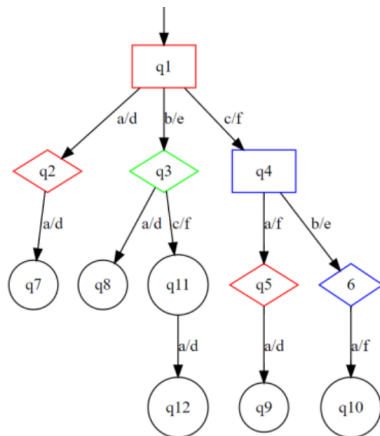
Equivalence query



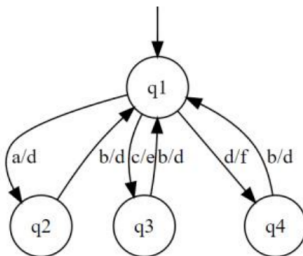
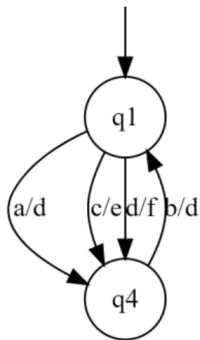
bca



Insert counter example



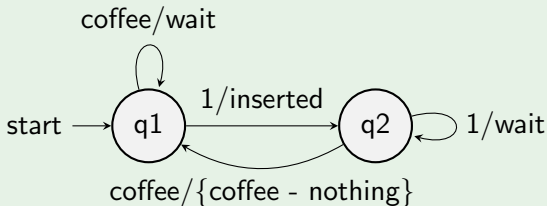
Minimizing



IGMM[5]

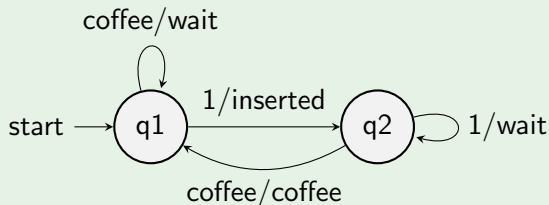
Incompletely specified Mealy machines

Example: Broken coffee machine model

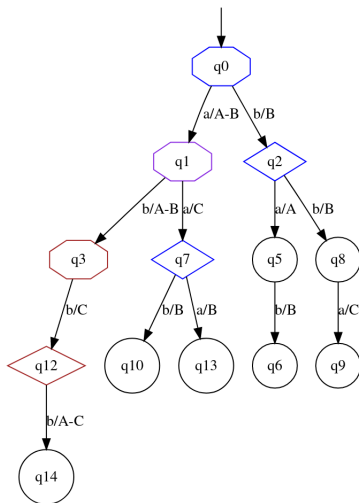


IGMM specialization

Example: Specialization of a broken coffee machine



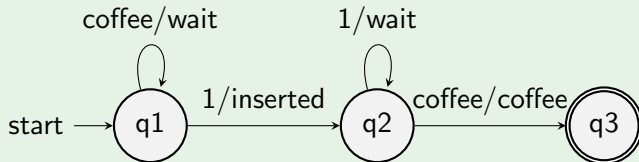
IGMM Observation Tree



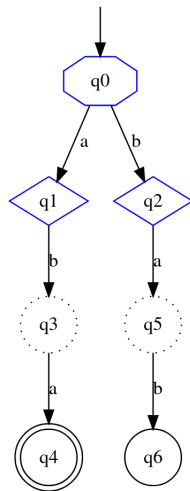
DFA

DFA

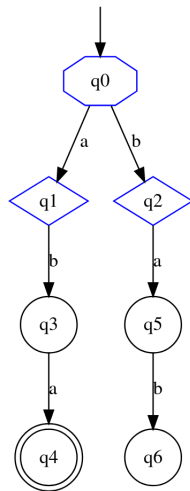
Example: DFA coffee machine



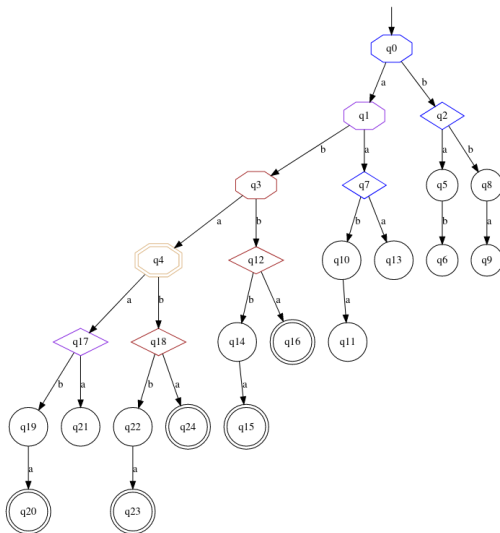
DFA Observation tree



DFA Observation tree



DFA Observation tree



Goals

Work done

- Implementation of IGMM in C++ in the new repo.
- Implementation of Lsharp for MM and DFA.
- Work on incompletely specified states in the observation tree.

Work to do

- Implementation of active learning for a specialization of IGMMs.

Conclusion

Bibliography



Dana Angluin.

Learning regular sets from queries and counterexamples.

Inf. Comput., 75(2):87–106, 1987.



Falk Howar, Oliver Bauer, Maik Merten, Bernhard Steffen, and Tiziana Margaria.

The teachers' crowd: The impact of distributed oracles on active automata learning.

volume 336 of *Communications in Computer and Information Science*, pages 232–247. Springer, 2011.



Frits W. Vaandrager, Bharat Garhewal, Jurriaan Rot, and Thorsten Wißmann.

A new approach for active automata learning based on apartness.

CoRR, abs/2107.05419, 2021.



Daniel Neider, Rick Smetsers, Frits W. Vaandrager, and Harco